

PRELIMINARY REPORT ON THE FLORA OF  
ONOTOA ATOLL, GILBERT ISLANDS

SCIENTIFIC INVESTIGATIONS IN MICRONESIA

Pacific Science Board

National Academy of Sciences-National Research Council

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by

Edwin T. Moul

## ACKNOWLEDGMENTS

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The author is grateful for the aid and assistance given by Mr. Harold J. Coolidge, Mrs. Lenore Smith and Miss Ernestine Akers. The cooperation and kindness of the British Colonial Government and its local representative, Mr. Richard Turpin and his wife added much to our comfort and success. The advice and assistance of my associates was a constant source of help and encouragement.

## INTRODUCTION

The report on the animals of the atoll has been published in the Atoll Research Bulletin #28, May 31, 1954. A preliminary report on the Geology of the atoll by Dr. Preston E. Cloud, Jr. can be found in the same publication #12, December 15, 1952.

The atoll of Onotoa (see map), totalling 5.2 square miles of land, is divided into 3 large inhabited islands designated as North Island, South Island and Tabuarorae and four quite small uninhabited islands known as Aonteuma, Abanekeneke, Nanntabuariki and Abeinringan. A population of approximately 1800 people live in this small area, hence all land that is at all useful has been planted in coconut groves. The smaller islands are primarily of coral gravel soils and supported a few coconut trees, with the exception of Nanntabuariki which had only scattered shrub growth. Sixty species of flowering plants have been identified. About 15 of these which are cultivated were confined to the village areas. A few species were represented by only one or two plants on the whole atoll.

## VEGETATION

### Coconut groves

Most of the land on the larger islands was covered with coconut trees. Small groves were also present on two of the smaller islands. The groves were generally made up of randomly scattered trees of varying heights and ages; a

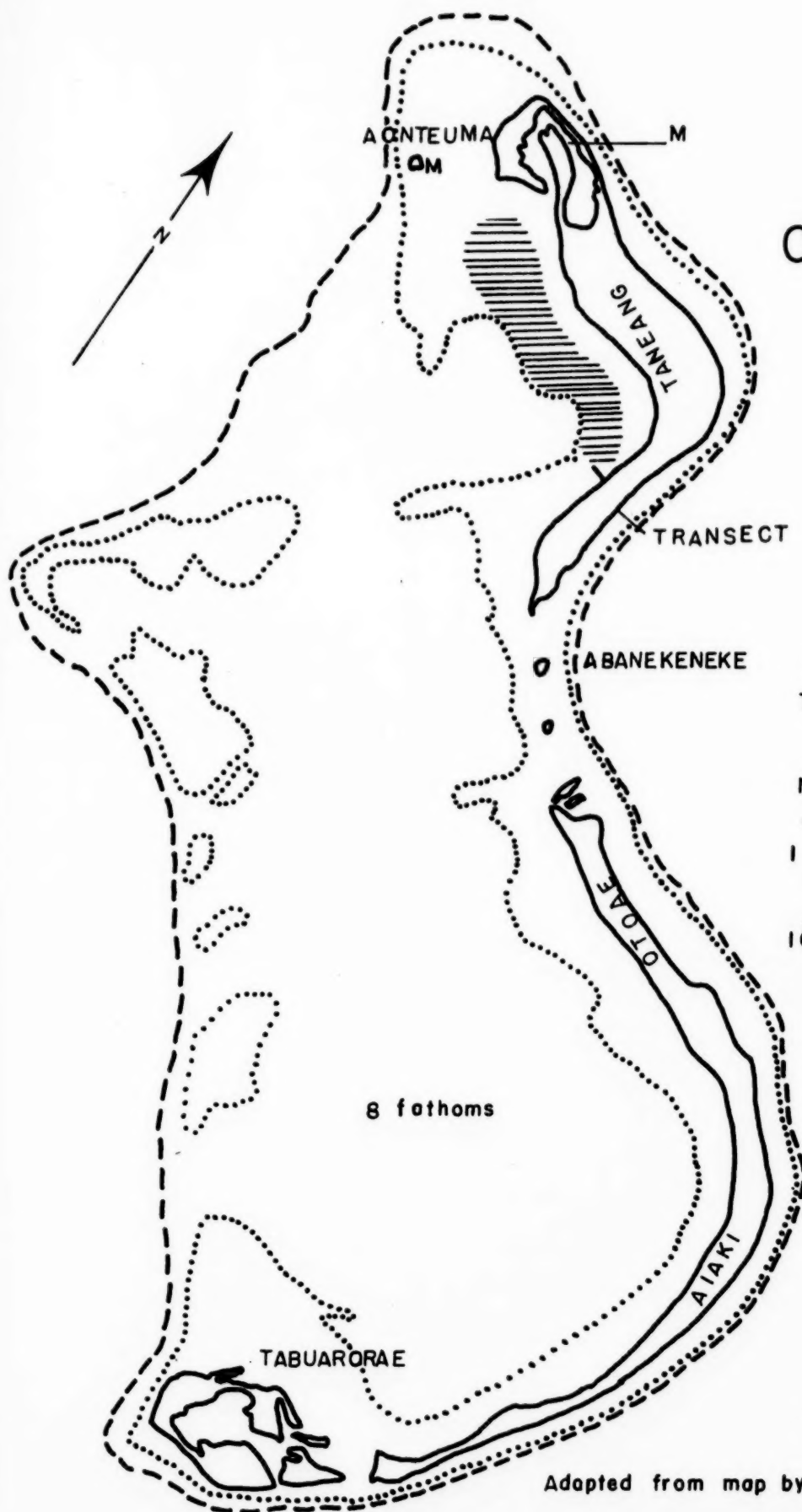
few recently planted ones (on formerly inhabited sites) were in regular rows and of uniform size and age.

The aspect of the coconut plantations varied with their location on the atoll, with the substratum and ground water conditions. Dense stands of coconut palms forming a continuous canopy, grew on the limesand soils (Cloud loc. cit., pp. 22, 58). Such vigorous groves were typical of the lagoon side of the islands, along the village road. They formed dense shade and had few understory plants. Young coconuts and Pandanus were usually present. Near the villages a few Ficus trees were found in these groves and appeared to have been planted. In the more or less well tended dense plantations, the soil surface was usually bare, except for a few grasses and herbs, Lepturus, Stenotaphrum, Euphorbia, Sida and Fimbristylis all growing widely scattered. In many areas an accumulation of fallen leaves and husks littered the soil and may have contributed to the sparseness of ground cover vegetation. The densest stand of Stenotaphrum observed on the atoll formed a complete ground cover in a grove on the North Island, where the soil surface had been cleared of all litter. Adjoining our camp site also on the North Island was a stand of coconut trees reported to be 15 years of age. These trees were planted in regular rows and were of uniform height. The owner had kept the soil clear of litter and in the dense shade the herbaceous vegetation grew widely scattered.


In contrast to these heavy groves, were the thin, irregular stands, usually located down the center of the large islands and on the seaward side, but generally on lime sand soil. Since the canopy was quite open, the understory here was well developed and showed an increased number of species. Messerschmidia, Guettarda, Pandanus, Scaevola and young coconuts formed the understory and, in some cases, very dense thickets. The ground cover here was also more extensive and consisted of mixed or pure stands of Sida, Lepturus, Fimbristylis, Triumfetta and Euphorbia. Blue-green algae and mosses covered the soil in many places between the clumps of herbs.

A few very poor groves occurred on the three larger islands on lime sand soil, but were more common at the exposed extremities of these islands on fine coral gravel soil and on the small islands of Aonteuma and Abanekeneke where the soil was also coral gravel. These stands consisted of a few widely scattered trees, usually old and sometimes infected with bracket fungus. The understory where developed was a dense thicket of Scaevola and Guettarda. The ground cover consisted of the same herbs listed above.

The effect of the recent year and a half of drought (1949-50) could be seen near the south end of South Island. The width of the island at this point is only about 50 feet from lagoon beach to seaward ramparts. The fresh water lens must have completely disappeared or become so shrunken that salt water penetrated into the soil, for nearly all the coconut palms were dead in this area. Scaevola, Pandanus and Guettarda did not show any serious effects.

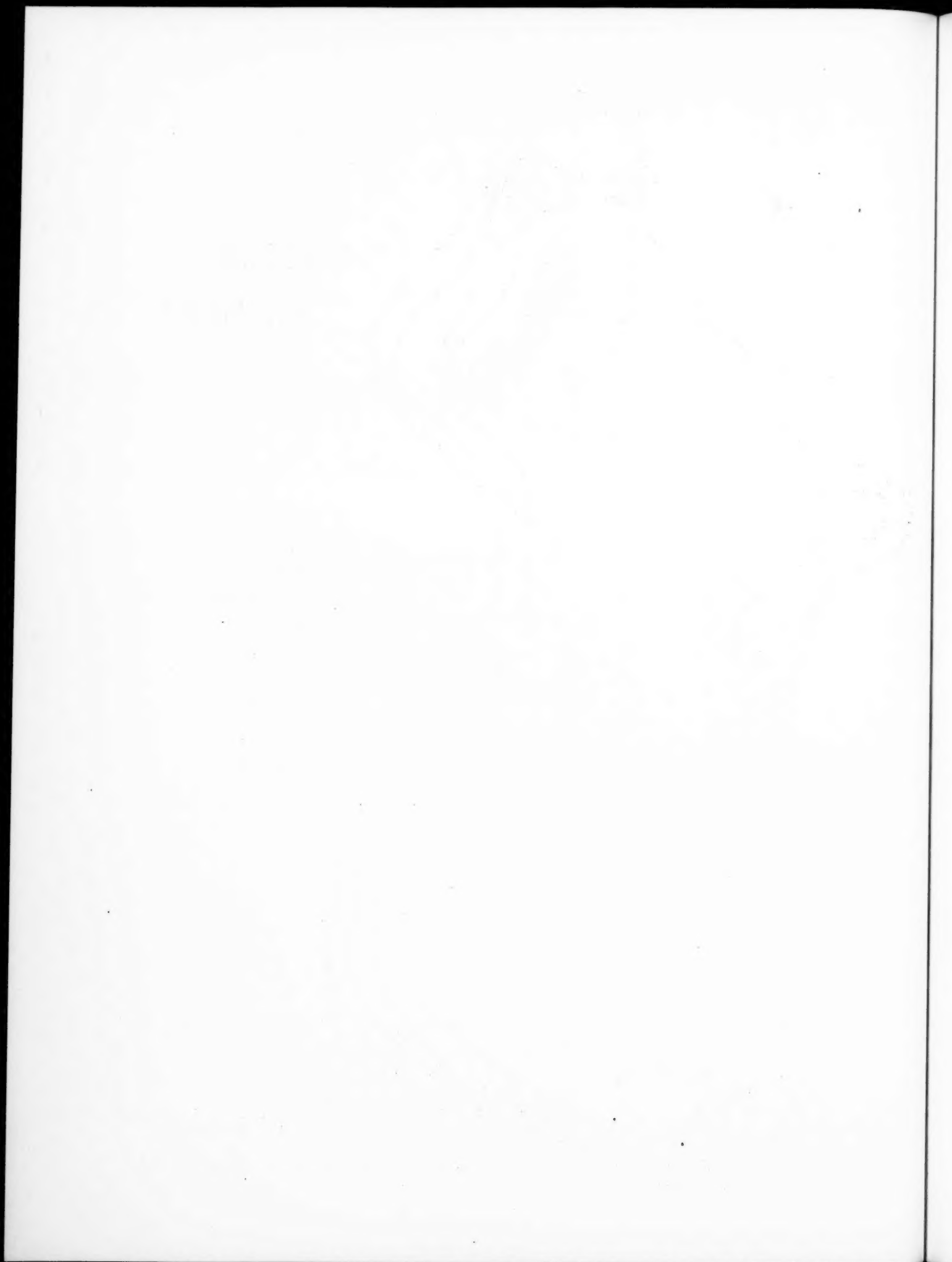


# ONOTOA, GILBERT IS.

  
 Turtle grass  
 M  
 Mangrove  
 .....  
 1 Fathom  
 line  
 - - - - -  
 10 Fathom  
 line

2 MILES.

Adapted from map by P. E. Cloud.



### Clearings

At intervals along the length of North Island occurred irregular clearings. There were no indications as to their origin. Lack of plantings and/or carelessness on the part of the owners may have been the reason for their existence. The soil appeared to be the same as in the best coconut groves.

In these clearings were found scattered thickets of Scaevola and Guettarda with some Pandanus and an occasional tree or clump of Messerschmidia. Many babai pits (taro) had been dug throughout this area. Generally one or two Messerschmidia trees were found growing at the edge on the mounds of earth. The dead leaves of this tree were gathered, piled up and later used as mulch around the Cyrtosperma (babai) plants in the pits.

The ground cover consisted of large irregular clumps of Sida fallax, Lepturus, Portulaca and Euphorbia chamissonis. In many cases these patches were of one species only. The bare areas of white sand between them had a broken crust of blue-green algae (Scytonema spp.) with mosses growing on it.

### Area of Brackish Pools

East of the village of Buariki on North Island and at the northern end of South Island were two areas of brackish pools. The soil was a silty lime type termed "caliche" by Cloud (loc. cit.). Widely scattered coconut trees were growing there. They were dwarfed and did not seem to bear a heavy crop of coconuts. Pemphis grew around the edges of the pools and in small thickets. Young coconut trees occurred in the understory, even in great abundance, on South Island. On North Island only scattered culms of Fimbristylis were present with crusts of blue-green algae covering much of the bare sand between them. On South Island the ground cover in this area was more lush and included Lepturus and Portulaca.

### Vegetation of the Seaward Ramparts

Thickets of Scaevola grew on top of the ramparts and showed signs of damage by salt spray on the seaward sides. Pandanus also grew sparsely along the top of the ramparts or back of the Scaevola either singly or in groups, and also showed signs of damage by salt spray. However some of these plants were able to produce large fruits in this situation. Messerschmidia was less common on the ramparts than Pandanus, occurring now and then on the crest. Cassytha was rare here, but occasionally grew on Scaevola.

On the inner slope of the ramparts, the vegetation was sparse and scattered, with areas of white sand between. Few coconuts grew on the slope, but the groves started at their base. Scaevola bushes grew on the slopes and down into the groves. Pandanus, Messerschmidia and Guettarda were more common on this slope than on the ramparts. Cassytha was rare here, but did parasitize Scaevola. Culms of Fimbristylis, alone or with Lepturus, were spotted here and there. Sida fallax and two species of Portulaca were also part of this community.



At the north end of North Island the rampart vegetation consisted of a pure stand of Pemphis. These shrubs attained a height varying from 10 to 15 feet and formed almost solid hedge-like thickets, broken by the paths made by the natives going through to the seaward reef.

#### Vegetation on Gravel Soil

At some places on the seaward side of the islands, on the northern point of North Island and on Aonteuma, Abanekeneke and Nanntabuariki the soil consisted of coarse and fine gravels. These were areas reached by waves and probably flooded during periods of storms. A few isolated Scaevola and Guettarda bushes were conspicuous against the bareness of the area. Some small Pisonia trees were found here, their leaves badly damaged by leaf cutting bees. Pandanus and Morinda citrifolia were represented by occasional dwarfed specimens. Lichens were collected on the bark of Guettarda growing in this habitat on Aonteuma.

The chief herbs on these areas were both species of Boerhavia, Sida fallax and the two species of Portulaca. The Boerhavia plants were large and the total spread of single plants reached as much as 8 feet. These were distributed widely, some growing in the shade of the Guettarda or Scaevola shrubs, while others were in the open. The few Sida plants were large and shrubby, but showed yellowing of the foliage. The Portulaca plants were in isolated clumps or as scattered individuals. Cassytha was common on the Guettarda and Scaevola bushes.

Further back from the shore line coarse coral fragments graded into finer fragments. The vegetation remained primarily the same, with the addition of a few isolated coconut palms. Premna was common on Aonteuma island on this fine gravel. Lepturus and Phyllanthus were additional ground cover plants, but only the latter really common.

#### Pisonia Groves

Some scattered Pisonia trees were located on the coral gravel areas on Aonteuma Island and on the north end of North Island, but on Tabuarorae there were two distinct narrow groves of large trees over 40 feet in height. These groves were on a ridge of indurated phosphatized limesand soil and the odor and droppings under these large trees indicated a big bird population. The nests of the smaller noddy tern were occupied at the time of our visit on July 25th. The soil was bare directly under the trees except for dead branches and fragments of logs, all soft and spongy. However, on both sides of the groves the vegetation was the most luxuriant seen on the atoll. The greatest number of species were also noted here. The predominant understory plant was Ficus, but young breadfruits, papayas, both flowering and bearing fruit, Guettarda, Pandanus and young coconuts were also present. A wide variety of herbaceous plants covered the ground under this shrub understory.

### Vegetation around Fish Ponds & Sand Flats

At the north end of North Island was a large fish pond which ended in extensive sand flats, partially flooded at high tide. The greatest concentration of mangrove, Rhizophora mucronata, bordered the fish ponds and grew on the part of the sand flats flooded by the tides. The only other mangroves observed were 2 trees and many small seedlings growing in the shallow calcareous sand of the embayment between Aonteuma and North Island.

The wetter sand flats, flooded at very high tide, had a heavy stand of mangrove that extended almost completely across. The fish pond was almost completely encircled by mangrove thickets growing in the shallow water. Back of the mangroves on higher ground was a zone of Pemphis, and coconut palms beyond the Pemphis.

The bottom of the fish pond was covered almost completely with turtle grass, Thalassia hemprichii. Green algae, mostly a species of Microdictyon, grew as epiphytes on the turtle grass.

The highest sand flats appeared to be dry most of the time and were flooded at only extreme high tides. The central part of these flats was bare white sand riddled with burrows of fiddler crabs. Pemphis formed a shrub border, but all of the shrubs that had grown far out on the flats were dead, only those along the edge were still living. Groves of coconut palms grew down to the edge of the flats.

### Babai pits (Taro pits)

The cultivation of Cyrtosperma for food was quite extensive on the atoll. Pits had been dug to a depth of 15 feet in the limesand soils in the center of the three large islands. Many of these were in the areas described above as clearings. On Tabuarorae there were many abandoned pits.

Since these pits were generally moist or flooded shallowly with water from the fresh water lens, algae samples were taken in many of them. Blue-green algae, Phacus and Rhizoclonium were common. Complete identification of the fresh water algae from these pits is being made.

A variety of flowering plants grew in these pits. Eleocharis geniculata and Cyperus laevigatus were common, the latter was quite abundant in several abandoned pits on Tabuarorae. The only banana plants seen on the atoll grew in one of the babai pits. Several large shrubs of Jussiaea suffruticosa were found growing in a pit east of the village of Aiaki.

The pits varied in size, but usually were between 25 and 30 feet long, with a width of 10 to 20 feet. Mr. Richard Turpin, the British Land Commissioner, told me that in some cases as many as 10 individuals owned little plots in a single pit. In many pits the natives had built up the humus around the largest plants by using mats of coconut leaves to form a circular wall and then had filled this with the leaves of Messerschmidia and

Guettarda along with the blackish sand found under old trees of these species. Some of the larger babai plants were flowering. Only in a few cases were the plants in a single pit of the same size.

#### Vegetation of sand dunes

On the southern tip of North Island, the southern tip of South Island and the northern tip of Tabuarorae are a series of low sand dunes. These areas are hot during the middle of the day because of their exposure to the sun. The white sand between the scattered shrubs causes an extreme glare.

The principal shrubs were Scaevola, Guettarda and Pemphis. These were the only shrubs present in this community on North Island, but on South Island and Tabuarorae Suriana, Sophora and Terminalia were also growing. Suriana, however, was common only on Tabuarorae. Cassytha had parasitized a number of these shrubs. Grasses and herbs were rare and since the sands were apparently shifting from time to time, no moss nor algae were present.

#### SPERMATOPHYTA

Sixty species of vascular plants were collected or observed by the author on Onotoa between June 24th and August 30th, 1951. In the following species list is included a short account of the occurrence and abundance of the plants. Native use is included whenever observed or learned. The author's collection number follows the name of the island on which collections were made. Native names obtained are included only if supplied by more than one authority. The first and second set of plants are deposited in the U. S. National Herbarium and the Herbarium of the Bernice P. Bishop Museum at Honolulu. The other duplicates are in the Chrysler Herbarium at Rutgers University, New York Botanical Garden, Gray Herbarium at Harvard, University of California Herbarium at Berkeley and the private herbarium of Dr. F. R. Fosberg.

#### Angiospermae: Monocotyledonae

##### PANDANACEAE

##### Pandanus tectorius Sol.

North Island 8364, 8412.

A list of native names supplied by our cook, Baru is given below. He also supplied information on the use made of some of these varieties by the natives.

te aramaru )  
te aramarieba )  
te bakororso  
te ulonau  
te aramoroi

both with small phalanges, leaves  
used for mat weaving.



te iribaikawa  
 te tina  
 te iritawatawa - tall straight trunk, used for supports in house building.  
 te aranteba  
 te annabai  
 te irikiri  
 te iriauriaria - large fruited variety, blackish cast on leaves

This is one of the three important plants in the native economy. It grows on limesand soils under the coconuts and on the fine gravels. Salt damaged specimens grew on the ramparts and a few stunted ones on the coarse gravels.

At one spot on North Island, new plantings had been made by taking a crown from a branch, tying the leaves together and planting these cuttings rather deep into the soil. These new plantings were in irregular rows in the shade of coconut trees.

The ripe fruit is known as "te tou". The fruit is taken apart and cooked, then the pulp is pressed from the base of the phalanges and spread on Guettarda leaves to dry in the sun. During the drying process the mass or pudding is usually covered with flies. It is called "te tuae". If this pudding is mixed with water, as a soup, it is then called "te kabubu".

#### HYDROCHARITACEAE

Thalassia hemprichii (Ehrenb.) Ascherson

Lagoon 8188.

Large beds of this aquatic plant were found in the north end of the central lagoon along the shore of North Island at the village of Taneang. The plants were deeply rooted in the limesand bottom and the leaves were only about 6 inches long. These beds were covered at low tide. The plants grew so densely that they caused the deposition of sand and fine silt. The green alga, Microdictyon, and a small gelatinous red alga were very abundant, both attached and floating among these weeds. Halimeda stuposa also grew in these areas. The bottom of the fish pond at the northern end of North Island was almost completely covered with Thalassia and many fish and invertebrates were present in the weed patches and on the individual plants.

#### GRAMINEAE

Cenchrus echinatus L.

"te anti".

North Island 8386; South Island 8206.

Found in just two sites on the atoll: thick solid stands are common along the road north of the village of Aiaki, and several single plants were growing along the road on North Island at our supply dump, south of the Government area. It seems certain this is a recent introduction and will probably spread undisputed over the atoll before long. The native

name given is the one used in the northern atoll of Makin and was supplied by Jim Redfern, our interpreter from Makin.

Lepturus repens (Forst.) R. Br.

North Island 8019, 8454; South Island 8212.

The commonest grass on the atoll, found on all the islands, the largest stands on the limesand soil, but rarely forming a turf. On the poorer soils, only widely scattered culms were present and usually in association with Fimbristylis cymosa. Scattered clumps grew on the seaward beach ramparts. The most vigorous plants were found along the lagoon roads.

Stenotaphrum micranthum (Desr.) Hubb.

North Island 8055, 8155.

The second most important grass on the atoll, restricted to the three large islands. It was found growing on limesand soil in the dense shade of coconut groves. It was also rather common around the edges of the babai pits in full sun. Many of the stands of this grass were dense and continuous in contrast to those of Lepturus. In the grove north of the Protestant Church, in the village area of Buariki on North Island was found the heaviest and largest stand anywhere on the atoll, covering almost completely a 5-acre tract.

Eragrostis amabilis (L.) W. & A.

"te uteute ni mwaane".

North Island 8130, 8339; South Island 8207.

Found as a turf at various places along the village road on both North and South Islands. Also common along paths in the center and north end of North Island. On Tabuarorae it grew on a narrow piece of high ground between the lagoon and the shrubby growth on the sand flats. Growing mixed with Cenchrus on South Island.

Wherever this grass was seen the soil seemed to be wet and dark in color with a great amount of humus. It was usually found only on the finer soils in which there were few or no gravel particles.

Eragrostis whitneyi Fosb.

"te uteute ni mwaane".

North Island 8090, 8316.

Confined to North Island. Growing on limesand soils along the lagoon road and along a path in a sunny area in the center of North Island. Common where it was found.

## CYPERACEAE

### Cyperus laevigatus L.

Tabuarorae 8224.

Collected only on this island in an abandoned babai pit. The bottom of the pit had a very shallow layer of water and the soil was held firmly by the roots and rhizomes of the plants. Formerly it was used for weaving.

### Eleocharis geniculata (L.) R. & S.

North Island 8158, 8337; South Island 8210.

Growing in some of the babai pits on North and South Islands. Not abundant in any of the pits.

### Fimbristylis cymosa R. Brown

"te uteute ni aine".

North Island 8021, 8129, 8281; South Island 8208.

A very common sedge on all the islands of the atoll, growing as scattered plants, never as a turf. Many of the culms on the beach ramparts and inner slope of the ramparts were dried up and apparently dead. Pure stands were frequently seen in the coconut groves along the lagoon road, at other places Fimbristylis was growing mixed with Lepturus. Around the brackish pools in the area of "caliche" soil on North Island this was the only vascular plant forming ground cover.

## PALMACEAE

### Cocos nucifera L.

"te ni".

North Island 8373; 8411.

Distribution of coconut palms on the atoll has been discussed in describing vegetation and need not be repeated here. The coconut is certainly the staff of life of the Onotoan. It supplies him with food, toddy, shelter, rope, matting, flooring, oil and medicine. The dried product of the nut is sold to the local cooperative trading company where commodities from the outside world can be purchased.

The gathering of the "toddy" was one of the most fascinating aspects of the coconut culture. Why certain trees were selected and others disregarded for toddy collecting I never did learn. However, it was said that some trees produced more than others. Toddy trees could be spotted, since notches were cut on the lower part of the trunk. The flower buds of these trees were tied shut to keep them from opening, then the tips were cut off. The dripping sap from these cut tips was drained into a bottle or empty coconut shell by using a leaflet of coconut as a gutter. Each morning and evening the young men or boys climbed the toddy trees and replaced the

filled containers with empty ones, making a fresh cut on the bud each time. The gatherer sat on the petiole of one of the large leaves and accompanied his labor with singing. To gather toddy and not sing would cause it to spoil. It was unearthly, but beautiful to hear these voices from the tree tops at dawn and dusk. All the singers had fine voices. Usually the songs were unfamiliar, but "From the Halls of Montezuma", "Silent Night, Holy Night", "You are My Sunshine", and some other familiar tunes with Gilbertese words were also heard at these times.

The toddy is used fresh, mixed with water and is then called "karawe". If the toddy is boiled to keep it from fermenting it becomes a brown syrup and then mixed with water as a refreshing drink it is called "kamaimai". It has the flavor of coca cola that has become somewhat flat from standing. If the toddy is allowed to ferment, which requires special permission, it becomes highly intoxicating. We saw its effect upon a young man who passed out while dancing at one of the feasts. A beetle of genus Sessinia gets into the toddy and if not noticed and removed causes a painful inflammation of the urinary tract.

Other native names associated with the coconut are as follows:

te ben --- a ripe coconut  
te riki -- a germinating coconut  
te mormoto - a drinking coconut

#### Pritchardia sp. ?

A single plant of a fan-palm growing in front of the Government House on North Island.

#### ARACEAE

Cyrtosperma chamissonis (Schott.) Merr. "te babai"

North Island 8132, 8157, 8159; South Island 8211.

Extensively cultivated in pits dug in the limesand soil to a depth of 10 to 15 feet. This was the only species found in cultivation for the starch stored in the roots. Plants of all sizes, some in bloom, were found in the pits. The natives build a circular wall of coconut matting around individual plants and build up a compost, using the leaves of Messerschmidia and Guettarda mixed with darkened limesand soil from under the older trees of these species.

The land tenure of these pits was rather interesting. The families using the pits usually did not own the land in which they were dug, but permission had been granted to their ancestors several generations before. Frequently, as many as 10 different families had plantings in one pit, none of which was larger than 20x50 feet; most were smaller. The only abandoned pits seen were on the eastern side of Tabuarorae.



Since the pits were dug to a depth that would intersect the water table, algae, principally blue-greens and Rhizoclonium, covered the wet soil or grew in the shallow water. One pit had a bloom of Phacus pleuronectes in it. Mosquitoes and dragon flies bred in these pits, as indicated in the report on the animals (Moul, 1954).

#### AMARYLLIDACEAE

Crinum asiaticum L.

"te kiepu".

North Island 8304.

Planted as an ornamental around the village houses, but not common. Also found planted in one of the cemeteries. Very few specimens were flowering during our stay on the atoll.

#### MUSACEAE

Musa sp.

Observed only once on the atoll: There were three trees in one of the babai pits on North Island. The plants were small and yellow green in color. In contrast, banana was common in the villages on Makin Atoll in the Northern Gilberts.

#### Dicotyledonae

#### MORACEAE

Artocarpus altilis (Park.) Fosb.

"te mai".

North Island 8299.

Breadfruit trees were planted on each side of the village streets along the lagoon shore. Many of the trees were small. Young trees were planted in a circular well lined with reef rock and the roots covered with humus and dead leaves. Coconut matting was used to cover the soil, allowing the young trees to grow between the mats. Many of the trees in Aiaki village were small and poor and some of them were dead. The largest trees were in the village of Tekawa, which is located on the widest part of North Island. All the trees along the street in the village of Tabuarorae were dead. The natives reported this to be the result of the 1949-1950 drought. The fruits seen were small, wrinkled and contained large seeds.

On the island of Tabuarorae, breadfruit trees of several sizes were seen in the luxuriant vegetation along the edges of the Pisonia grove. This area was underlain with phosphate deposits, attributed to the birds nesting in the Pisonia trees. These groves were formerly more extensive and covered the area where the breadfruits were now growing.

Ficus tinctoria Forst.

"te bero".

North Island 8057, 8128; Tabuarorae 8232.

Small trees were found growing on the three large islands. From their distribution it seemed apparent that most of them had been planted. These trees were growing around the edges of many of the babai pits and, in one case, in an abandoned pit. Others were planted around the houses in the villages. On North Island a row had been planted at regular intervals along a path through the coconut grove. On Tabuarorae they formed small thickets around the Pisonia grove. The fruits were small and used as food.

#### URTICACEAE

Fleurya ruderalis (Forst.) Gaud. ex Wedd.

"te nekeneke".

North Island 8147, 8336; Tabuarorae 8228.

Common only at one spot on North Island, around a copra hut. Very common in many stands under the Pisonia trees on Tabuarorae. A native girl brought specimen 8336 to camp to trade for cigarettes. I presume these plants came from North Island.

#### NYCTAGINACEAE

Boerhavia diffusa L.

"te wao".

North Island 8037, 8039, 8085, 8106, 8134, 8340; South Island 8198; Abanekeneke 8141.

A common plant of the seaward side of the islands, growing on both the fine and coarse coral gravel soils. Frequently found on the beach ramparts, sometimes under dead or living Scaevola shrubs. It was very common all over the coral gravel of the old village site on Abanekeneke. In some cases the sprawling plants spread a distance of 4 feet in all directions from the root. Both flowers and fruit were present on most plants. The flowers were pink in most cases, but a few of the plants assigned to this species had white flowers. These plants showed some intermediate characters between this and B. tetrandra and may be hybrids. (8141, 8198).

This and B. tetrandra are used as food for hogs.

B. tetrandra Forster

"te waonnansi".

North Island 8084, 8151; South Island 8202; Tabuarorae 8223.

The rarer of the two species found on the atoll. Growing on coral gravels and boulder ridges of the seaward side of North and South Islands. On Tabuarorae, however, it was very common on the limesand soils in the thin coconut groves. Flowers and fruit were present on most plants. The flowers were white in this species.

Pisonia grandis R. Brown

"te buka".

Aonteuma 8082; North Island 8152; Tabuarorae 8229.

Two long narrow groves of these trees about 40 feet tall were found on a ridge of indurated phosphatized limesand soil (Cloud 1952) on Tabuarorae. The only other specimens seen were a few trees on the north end of Aonteuma on coral gravel and two small groups of trees on North Island. One of these groups on the north tip of the Island grew on coral gravel and the other group was near the brackish pools on the seaward side of the island. The trees on Aonteuma and North Island had leaves badly damaged by leaf-cutting bees.

The large trees on Tabuarorae had large buttressed trunks; many would have required at least three men with arms extended to completely encircle them. The wood was very soft. The odor of ammonia was strong under these trees, due to the excrement from the large colony of nesting terns. The most luxuriant vegetation on any of the islands was on either side of these groves and consisted of Ficus, papaya, Morinda citrifolia, breadfruit saplings, with a heavy ground cover of Fleurya and grasses.

Bougainvillea spectabilis Willd.

The record for this plant is based on the appearance of the flowers in a "lei" worn by one of the girls on August 16th. On questioning her, it was learned that the plant grew in the yard of the house assigned to the native preacher of the village of Buariki.

Mirabilis jalapa L.

A cultivated ornamental planted around some of the houses in the village of Aiaki on South Island.

#### PORTULACACEAE

Portulaca lutea Solander

"te mtea".

North Island 8022, 8073, 8089, 8341, 8451.

The larger leaved of the two species growing on the atoll. Great variation was noticed in the coloring of the stems of these plants, some were red.

Growing on limesand and coral gravel soils and in the groves, clearings, and on beach ramparts and their inner slope. Observed on all the islands of the atoll. In places on coral gravels it formed thick stands. The natives reported that it was used as pig food and as human food in times of famine.

Portulaca samoensis V. Poelln.

"te mtea".

North Island 8023, 8072, 8107, 8284, 8395; South Island 8199.

Distribution much the same as the other species and used by the native population for the same purpose. Apparently no distinction is made by them between the species.

#### LAURACEAE

Cassytha filiformis L.

"te ntanini".

North Island 8056, 8058, 8431.

A parasitic member of the family having a superficial resemblance to dodder (Cuscuta). It was found growing principally on Scaevola sericea and Guettarda speciosa, occasionally attached to Euphorbia chamissonis and Pemphis. One plant was found growing on Suriana maritima, on the island of Tabuarorae. Common along the beach rampart, rarer on the inner slope, but frequent in the sunny open areas in the center of the large islands. Widespread in the atoll wherever the host plants grew. Flowers and fruit were present during the expedition's stay on the atoll.

#### HERNANDIACEAE

Hernandia sonora L.

"te nimaa repwurepwa".

South Island 8195.

One small tree, possibly the only one on the atoll, found along the lagoon road south of the village of Aiaki on South Island. The wood was formerly used for outriggers.

#### LEGUMINOSAE

Delonix regia (Boj.) Raf.

"te tau".

North Island 8296.

One small tree, 6 feet tall, growing beside a house in the village of Buariki, North Island. Flowers and fruit were not present. This was the only specimen seen on the atoll.

Sophora tomentosa L.

"te nikamaatuutuu".

South Island 8192; Tabuarorae 8154.

A common shrub on the narrow southern tip of South Island where the coconut trees had been killed by the drought. Growing on dune sands. The only other occurrence was on Tabuarorae as a member of the shrub community on the sand flats and bordering the inlets at the northeast end of the



island. Flowers and fruit were present on most of the shrubs.

SURIANACEAE (often included in the SIMARUBACEAE)

Suriana maritima L.

Tabuarorae 8226, 8308.

This shrub was common only on Tabuarorae. It grew on dune sand on the shore of the lagoon and as a member of the shrubby thicket on the flats at the northeast corner of the island. Fairly common as a member of the understory of the coconut groves on this part of the island. Young seedlings were present. The only other specimens seen were on the lagoon shore in the village of Buariki on North Island.

EUPHORBIACEAE

Euphorbia chamissonis Boiss.

"te tarai".

North Island 8059, 8365.

This plant, with Sida fallax, formed low shrubby thickets in the center of the large islands and in many clearings in the coconut plantations. In the shade of the groves on the fine limesand soil, scattered plants of this species were frequently the only ground cover. In other groves it grew with Lepturus and Sida to form the ground cover. It was second in importance to Sida. The natives made no use of this plant.

Euphorbia prostrata Ait.

North Island 8092, 8146.

Not a common plant, but abundant where it grew. It was the dominant ground cover in the deep shade of a coconut grove at the north end of North Island. The coral gravel spread around the village houses was usually kept clear of vegetation, but in the village of Aiaki on South Island this plant was abundant in a number of these gravel yards.

Phyllanthus niruri L.

North Island 8087, 8148; Tabuarorae 8231.

Growing in the coconut groves on the three large islands, but not a common member of the ground cover. Found on lime soils and fine coral gravels. Restricted to the village areas along the lagoon. At the extreme northern end of North Island it was confined to an area of scattered copra huts. One of the common herbs found in the Pisonia groves.

SAPINDACEAE

Dodonaea viscosa (L.) Jacq.

"te kaipora".

Aonteuma 8083; North Island 8303.

Found growing as a low shrub in the thin coconut grove on Aonteuma. Later, several plants were observed in the village of Buariki. Used in scenting the oil for the hair.

TILIACEAE

Triumfetta procumbens Forster

"te kiaou".

North Island 8040, 8094, 8105, 8131; Tabuarorae 8234.

Fairly common on the larger islands. It was found growing on the ramparts on dune sand and was also rather common on sandy soil in the central portion of the islands. In coconut groves it frequently grew up between and over the litter scattered on the ground; some of the runners were as long as four feet. It was in flower and fruit during the period of our stay on the island.

Used medicinally by the natives for poultices and drunk as tea during child birth. Also reported used as soap.

MALVACEAE

Hibiscus rosa-sinensis L.

These plants were reported as growing in the compound of one of the native preachers, but were not located. On August 13th one of the native girls was observed with these flowers in her hair.

Hibiscus tiliaceus L.

"te kiaiai".

North Island 8300, 8306, 8449.

Only two groups of these trees were found on the atoll and both were on North Island. The trees growing along the lagoon shore in the village of Buariki were the largest and were in full bloom during our visit. The other group of trees were at the south end along the road in the village of Temao. Here there was one old tree surrounded by many small ones.

The flowers, yellow with red centers, were used as ornaments in the hair of the villagers.

Sida fallax Walp.

"te kaiao" and "te kaura".

North Island 8020, 8088, 8282.

One of the most widely distributed ground cover plants on the atoll,

growing at some places to a height of 2 feet. It was found on all types of soil, but was most abundant on the limesand soils under the coconut trees. Plants growing on the coral gravels were usually chlorotic. Flowers and fruit were present during the whole period of our stay on the islands. The larvae of the common butterfly, (Hypolimnas bolina), were abundant on the foliage.

The flowers were the favorite for making the head "leis" that everyone wore. Children following along with the collector made "leis" as they went, and the author rarely came back from an expedition without wearing one contributed by them. Sometimes the plants are used as part of the compost for the babai pits.

#### GUTTIFERAE

Calophyllum inophyllum L.

"te itai".

North Island 8127; South Island 8203.

This tree was rare on the atoll. There were two large trees in a coconut grove on North Island. Another single tree about 25 feet tall was located east of the lagoon road at the south end of South Island. Flowers and fruit were lacking. The trees were observed in bloom on the Atoll of Majuro in the Marshall Islands on the trip to Onotoa. The lumber was formerly used in canoe building. Because of the present scarcity, it was now being used only for canoe paddles. A brown skipper butterfly was caught on the leaves of this tree and another observed flying about. These insects were observed nowhere else on the atoll and were probably specific to this plant.

#### CARICACEAE

Carica papaya L.

North Island 8150, 8153; Tabuarorae 8230.

Planted around a few of the houses in the villages; but not a common cultivated plant. Many small plants were found around an isolated copra hut at the north end of North Island. The largest number were growing in and around the Pisonia groves on Tabuarorae. The plants were in flower and fruit during our stay on the island. The natives sold us the fruit which we ate for breakfast. They were of good quality and quite good flavor.

#### LYTHRACEAE

Pemphis acidula Forst.

"te ngea".

North Island 8036, 8050, 8086, 8315.

One of the common shrubs of the atoll, growing on sand dunes at the ends of the larger islands and on the gravel soils of the smaller ones.

In some places it formed thickets on top of the seaward ramparts. It was common also along the lagoon shore away from the villages. On North Island it formed a complete zone between the Rhizophora and the coconut palms at the margin of the fish ponds and also grew on the tidal flats at the upper end of the ponds. Shrubs that had grown far out on these tidal flats were now dead, probably from the higher salinity resulting from the drought of the last year and a half.

In two areas of brackish ponds, one on North Island and one on South Island, Pemphis formed the dominant shrub of the understory.

Flowers and fruit were present during our stay on the island. A Catocala-like moth (Achaea janata) was very abundant on foliage. Cassytha filiformis grew on Pemphis occasionally.

Jussiaea suffruticosa L.

South Island 8209.

Several large shrubs grew in a wet babai pit east of the village of Aiaki. These were the only specimens seen. The flowers were yellow and were present on the same shrubs with ripe seed pods.

#### BARRINGTONIACEAE

Barringtonia asiatica (L.) Kurz

"te usi".

South Island 8205.

One small immature tree in a shallow pit on South Island, south of the village of Aiaki. The leaves were large, dark green and glossy with short red petioles. No fruit nor blossoms were observed on Onotoa. Ripe fruit were seen on Makin, Gilbert Islands, on the trip to Onotoa.

One afternoon in the Maneaba (Community house) at Aiaki, as I was passing around plant specimens in order to secure the native names, one of the group of natives told the interpreter that this tree was the only one on the atoll and was on his land. He added that the young fruit was used to poison fish and, in the old days, to poison people.

#### RHIZOPHORACEAE

Rhizophora mucronata Lam.

North Island 8051, 8098; Aonteuma 8077.

Confined to the north end of North Island and an embayment between it and Aonteuma. The largest stand surrounded the fish ponds and the tidal flats at the upper end of the ponds. Only two small mature trees were growing in the Aonteuma embayment, but there were many small seedlings all along the lagoon shore. The trees were in bloom and also had fruit with pendent radicles.

## COMBRETACEAE

Terminalia samoensis Rech.

"te ukina".

Aonteuma 8081; South Island 8191; Tabuarorae 8225.

A few widely scattered specimens of shrub size found only on the three islands listed above. They were growing on dune sand or coral gravel soils. The fruit on the Aonteuma specimens were green on July 9th. The fruit collected on South Island on July 23rd, and Tabuarorae on July 26th were scarlet. One large tree grew on the seaward rampart on South Island. The fruits were used as decorations and in making "leis". Apparently they were not eaten.

## ARALIACEAE

Polyscias guilfoylei (Cogn. & March.) Bailey

"te butatora".

North Island 8305.

Planted in hedges. Observed in the villages of Buariki, Taneang-Tekawa and Aiaki. The leaves were green and white and the dried plants were very fragrant.

## APOCYNACEAE

Catharanthus roseus (L.) G. Don.

"te buraroti".

North Island 8279.

One of the common ornamentals planted around the village houses. The white and purple flowered varieties were observed.

Nerium oleander L.

"te orion".

North Island 8302.

One small shrub at a village house in Buariki. The natives knew it contained a poisonous substance.

## CONVOLVULACEAE

Ipomoea tuba (Schlecht) G. Don

"te ruku".

North Island 8338; South Island 8197.

This plant was found only at the two sites represented by the collections. It was most abundant on South Island near the seaward side, where it was very common and formed a dense tangle on trees, shrubs and ground. On North Island it was growing on the coral gravel soil of the rampart and was not abundant. Neither fruit nor flowers were observed.



Reportedly used as medicine to attract the girls. The common Ipomoea pes-caprae, so abundant on the island of Betio at Tarawa Atoll and on other islands visited, was missing here.

#### BORAGINACEAE

Messerschmidia argentea (L.f.) I. M. Johnston "te ren".

Aonteuma 8076; North Island 8156, 8279.

A common tree of the atoll, growing on all the islands except the very small ones. Frequently found in the coconut groves and a common member of the understory on Tabuarorae. It was more abundant along the seaward rampart and along the edges of the clearings. One to several of these trees always grew on the edges of the babai pits. The leaves were collected and used for compost around the babai plants. It grew on sand and gravel soils. It was in flower and fruit during our stay.

Messerschmidia was commonly infested with a caterpillar, probably the larval stage of a small Nymphalid butterfly, and also the colorful moth Utetheisa. The moth was usually at rest on the underside of the leaves.

#### VERBENACEAE

Lantana camara L.

This plant was not collected. It was growing around one or two village houses. It was used by the girls as hair decoration.

Clerodendrum inerme (L.) Gaertn. "te inato".

Aonteuma 8080; North Island 8298.

Small shrubs which tended to be vine-like, were growing on Aonteuma. They were in thickets of Guettarda and Scaevola and under the coconuts. The soil here was coral gravel. Neither flowers nor fruit were present.

They were also found around some of the houses in the village of Buariki. The flowers were used in making "leis".

Premna obtusifolia R. Br. "te aango".

Aonteuma 8078; South Island 8194, 8196.

A common shrub of the south end of Aonteuma, growing on coral gravel soil. The only other occurrence was on the lagoon shore of South Island, south of the village of Aiaki. Here some of the shrubs grew to a height of fifteen feet. Flowers and fruit were present during our stay on the atoll. Premna was reported to be used as a medicine. Some of the leaves showed damage by leaf-cutting bees.

## SOLANACEAE

### Physalis lanceifolia Nees

North Island 8093, 8149.

A few plants growing beside a copra shack at the northern end of North Island. No other specimens seen, both collections being made at the same site. Flowers and fruit were present.

## SCROPHULARIACEAE

### Russelia equisetiformis Schlecht & Cham.

"te kaibaun".

North Island 8167, 8307, 8387.

A common plant around the Residency and the village homes.

Collections were made only on North Island, but the plant was present on South Island and Tabuarorae. The scarlet flowers were highly prized for "leis".

## ACANTHACEAE

### Pseuderanthemum carruthersii Seem.

"te roti".

North Island 8038, 8301.

Commonly cultivated and growing around the houses in all the villages. In the cemeteries at the northern and southern tips of North Island, a number of graves had these shrubs growing at one end. Two varieties were observed. One variety had purplish-green leaves, dark twigs and magenta flowers. The other variety had green leaves and light colored twigs. No flowers were observed on the latter.

## RUBIACEAE

### Guettarda speciosa L.

"te uri".

North Island 8041, 8280, 8333; Aonteuma 8079.

Second in importance to Scaevola as an understory tree and thicket former. It was found on all types of soils on all the islands, including the very small coral gravel islands between North and South Islands. Flowers and fruit were present during the time we were on the atoll. It was frequently parasitized by Cassytha filiformis.

The fragrant flowers were used by the natives for "leis". The women spread a dozen or so leaves on the ground on which to dry the pandanus pulp. The skin from the fruit of this plant, with a part of the root of Scaevola, were said to be used to cure venereal disease. These were crushed

together, the juice put into a drinking coconut and this mixture drunk by the patient. One treatment is said to be effective.

Morinda citrifolia L.

"te non".

Abanekeneke 8104, 8140; Tabuarorae 8227.

This plant was found growing principally below the ramparts on the seaward side of the islands. Also a member of the Pisonia grove community. It most frequently grew on coral gravel soils. Signs of damage by salt spray were evident on the small island of Nanntabuariki. The trees on North Island had been attacked by the leaf-cutting bees. A large Sphingid caterpillar, larva of the day-flying hawk moth, was found on the foliage of the trees in the cemetery on North Island. The tree was also planted around the houses in the villages. Both flowers and fruit were present during our stay on the island. The fruit is used as food in times of famine, but apparently not highly regarded or used at other times.

#### GOODENIACEAE

Scaevola sericea Jahl

"te mao".

North Island 8024, 8283, 8396.

The commonest understory and thicket former on the atoll. It was present on all the islands and grew on all types of soil. It formed dense thickets in the neglected coconut groves. On the seaward ramparts it formed solid thickets at many places and these plants showed a considerable amount of killing by salt spray. New shoots, however, arise directly from the root stock. It was in flower and fruit during the time we were on the atoll and was frequently parasitized by Cassytha filiformis.

#### COMPOSITAE

Vernonia cinerea (L.) Less.

"te waonnansi"

South Island 8193.

This small composite was found growing along the lagoon road both north and south of the village of Aiaki, South Island. It was fairly common in this area, but not found at any other location on the atoll. The flowers were light purple.



## PTERIDOPHYTA

No members of this group of plants grew on Onotoa.

Polypodium scolopendria was common on Majuro Atoll, Marshall Islands. IX/5/51.

## BRYOPHYTA

The mosses and liverworts collected on the expedition to Onotoa were determined by Dr. H. A. Miller and samples retained in his collection. Duplicate specimens were distributed to the Herbaria indicated above.

Because of the irregular amount of rainfall on Onotoa, with long periods of drought, Bryophytes were not common on the atoll. Mosses grew on the lime-sand soil along roads and paths and on soil bare of vascular plants. The heaviest growth was in the shade of trees. Most of the moss patches were surrounded by a thick growth of terrestrial blue-green algae. Black tufts of Scytonema ocellatum frequently were mixed with the moss plants and suggested the presence of another species. Only one species of moss was found and no liverworts were collected on Onotoa. Dixon (1927: Jour. Bot. 65:254.) has previously recorded Brachymerium indicum (Doz. & Mott.) Bry. Jav. as occurring on Onotoa, but this species did not show up in the collections. Miller indicates the one species found to be Brachymerium melanothecium (C. Müll.) Jaeg. and states that it is widespread in Oceania. The following collections were made:

North Island 8060, 8061, 8095, 8176.  
South Island 8213.  
Tabuarorae 8241.

On the trip out to Onotoa from Kwajalein Atoll, there were opportunities to collect on the various atolls visited. These collections are included below.

## MUSCI

Calymperes tenerum C. Müll.

Majuro Atoll, Marshall Islands.

8002. Growing on the trunk of a palm tree in a shaded area,  
Rogeron Island, VI/18/51.  
8621. Growing on a breadfruit tree, Rogeron Island. VI/18/51.

Kwajalein Atoll, Marshall Islands.

8001. Base of palm tree. Kwadak Island. Species widespread in Oceania. (Miller, 1953, p. 5).

Calymperes thyridioides Broth.

Majuro Atoll, Marshall Islands.

8005. On rotten wood in a Scaevola thickets. Uligak Island. VI/19/51.

Previously reported from Arno Atoll and other places in the Marshalls as C. moluccense by Miller, 1953, p. 4. (Miller personal correspondence).

#### HEPATICAE

Archilejeunea mariana (Gott.) St.

Kwajalein Atoll, Marshall Islands.

8000. On the bark of Pisonia trees. Fairly common on the horizontal branches. Wooded center of Kwadak Island. VI/17/51.

According to Miller (Correspondence) this is a rather depauperate specimen but falls within the range of the species. Widespread in Oceania.

Hygrolejeunea vesicata (Mitt.) Stephani

Majuro Atoll, Marshall Islands.

8003. On the trunk of a palm tree. Rogeron Island. VI/18/51. Miller states (Correspondence) that he believes this species belongs in Cheilolejeunea. The material from the Marshalls is slightly smaller than the type.

#### LICHENES

The few lichens found have been turned over to Dr. George A. Llano, Maxwell Field, Alabama, for determination. These collections were made in dense thickets on the bark of Guettarda, Morinda, Pandanus and coconut trees.

#### FUNGI

The fungus collections made on Onotoa have been turned over to Dr. Donald P. Rogers at the New York Botanical Garden and determinations have not been made at this date.

A number of species of bracket fungi were collected on rotting logs. The commonest was a red polypore. A reticulate orange slime mold was found on decaying pandanus leaves. A white gilled fungus was collected several times from the base of living coconut palms. Fungus beetles were present in some of the specimens collected.

## Soil Flora

Samples of soil were collected on the atoll and brought back to the Department of Microbiology at Rutgers University. The analysis of the flora of these soils was made through the kindness of Dr. R. L. Starkey and Dr. Hubert A. Lechevalier. I quote from Dr. Starkey's report:

"These represent determinations for numbers of bacteria and actinomycetes determined by the customary agar plate procedures.

Sample No.	pH	Numbers of microorganisms, per gram of soil		
		Bacteria	Actinomycetes	%Actinomycetes
8335	8.0	328,000	4,957,000	94
8243	8.4	200,000	3,982,000	95
8332	8.0	971,000	2,100,000	68
8120	8.0	1,705,000	6,140,000	82

It is to be noted that the reaction of all soils was distinctly alkaline. Of particular interest is the fact that the numbers of bacteria were in all cases lower than those of actinomycetes and that with 3 of the 4 soils more than 80 per cent of the colonies that developed on the agar plates were those of actinomycetes. A similar observation was made with soil obtained some years ago from Bikini. This is contrary to what one expects to find in soils of temperate regions particularly those of humid climates. These soils are generally acid (pH 6.0 or less) and the percentage of the total colonies that are produced by actinomycetes generally vary between 5 and 40 per cent.

The predominance of actinomycetes is interesting in view of the fact that many of these organisms produce antibiotics. It is possible, therefore, that the actinomycetes affect the transformations of material in the soils by their antagonistic effects. It is also possible that some actinomycetes may be obtained from these soils that will serve some useful purpose as producers of new chemotherapeutic substances."

### Sources of the Soils

- 8120. Lime sand soil from the center of North Island.
- 8243. Lime sand soil from Tabuarorae under vegetation.
- 8332. Soil from babai pit. North Island.
- 8335. Soil from under Guettarda tree, south end of North Island.

## ALGAE

### Taxonomy and Distribution of Algae

The algae from Onotoa include both fresh-water and marine forms. The fresh-water habitats include the soil surface, the babai pits and the brackish pools. The marine habitats include the beach rock, lagoon and the seaward (windward) reef. Many of the lagoon collections were made by Dr. Preston E. Cloud, Jr., Dr. Donald W. Strasburg and Dr. A. H. Banner while carrying out their own explorations. The identification of the algae is still in preliminary stages and much material remains to be determined. The identification of the Myxophyta to species has been done by Dr. Francis Drouet at the Chicago Museum of Natural History and specimens are deposited there. As identification proceeds complete sets of all algae are being deposited in the U. S. National Herbarium, Bernice P. Bishop Museum, and the Chrysler Herbarium at Rutgers University. Duplicates have been distributed to the New York Botanical Garden, University of California Herbarium at Berkeley, University of Michigan Herbarium, Farlow Herbarium at Harvard and the Herbarium of the University of Sao Paulo, Brazil.

The following report includes a limited and preliminary discussion of the ecology of the algae on the atoll, followed by a species list of the algae identified to date. It is the hope of the author to publish a detailed final report on the algae at a future date. A paper on the Halimeda and Caulerpa of the atoll is already in manuscript form and will be submitted for publication shortly.

#### Algae of the soil surface.

The surface of the road that parallels the lagoon from North Island to Tabuarorae was covered by a "skin" of blue-green algae. This was also true of the well-worn paths and the soil where it was bare of vascular plants and remained undisturbed. Two species of Schizothrix and Scytonema hofmannii were very common and formed the bulk of this association. Other blue-greens occurred with these principal species. Some black moss-like tufts growing around areas occupied by mosses proved to be Scytonema ocellatum. The dune sands of the seaward rampart and the lagoon shore had Microcoleus chthonoplastes and Scytonema hofmannii as the dominant algae. It is interesting to note that this species of Microcoleus is the dominant alga covering the peat surface on the salt marshes of New Jersey. These terrestrial blue-greens were present as a soil covering on the bare areas all over the atoll, both in sun and shade.

It has been established that many of the blue-greens, especially those belonging to the Nostocales, can fix nitrogen. The presence on the soil of vast sheets comprising many species suspected of having this ability may be very significant in the productivity of the soil. This is probably an important method by which this element is made available to higher plants (Newhouse, 1954, p. 53). The holding of soil against wind erosion is another important contribution of this group of plants.



### Algae of the babai pits.

The native taro, called babai (Cyrtosperma chamissonis), is grown in pits dug to the water table. The amount of water present in the pits varied from 6 inches of standing water to just enough to dampen the soil. In all the pits thick mats or scums were present. Collections of these scums were made in many of the pits, and the algal flora showed considerable variation. In some, Rhizoclonium hieroglyphicum was dominant. In others, members of the blue-green algae, such as Anacystis dimidiata, Plectonema nostocorum and Coccochloris stagnina, were dominant. One pit sampled had as the dominant form Phacus pleuronectes; associated with it were members of the genus Euglena.

Here again members of the Myxophyta were probably contributing available nitrogen compounds to the soil and thus to the growing babai plants. The algae here were the primary producers in the food chain that supported the protozoa, rotifers, nematodes, ostracods, and eventually the dipterous larvae and dragonfly nymphs present in these pits.

One of the fresh-water wells used by the natives in the Government Area on North Island was found to have a mat of Rhizoclonium hieroglyphicum floating on the water surface. The water level in the well was approximately 8 feet below the surface of the soil. The opening of the well was between 3 and 4 feet in diameter which admitted sufficient light for growth.

### Algae of the brackish pools.

In the area of caliche soil on the Pemphis flats at the north end of North Island there were a number of brackish pools (Cloud: 1952. Atoll Res. Bull. 12:60). These pools were covered by a floating, orange-colored gelatinous mat. The shaded portions and the under surface of the mat were olive-green in color. Two species of Anacystis were the dominant algae, with Coccochloris stagnina and three species of Lyngbya also present. The bottoms of these pools were lined with a more granular and warty mat. The same species were present, but the Lyngbya species were more abundant. A similar association for brackish pools has been reported by Newhouse (1954, p. 42). The same association of living organisms described above for the babai pits was present in these pools.

### MARINE HABITATS

The distribution of the marine algae is best discussed under the two major marine habitats, the lagoon and the seaward (windward) reef. There are beach rock associations in both areas that have somewhat different associations of algae present.

A complete description of the geology and topography of the lagoon has been published by Cloud (1952, p. 18). Algal growth in the lagoon as a whole was relatively sparse. The areas of the lagoon are described below with an account of the principal algal species present.

### Beach rock of the lagoon.

At a number of places along the shore of North Island there were outcroppings of beach rock. Near the village of Taneang a long ridge extended out from the beach at an angle of  $45^{\circ}$ . Collections of algae made from the surface of these rocks showed two species of Entophysalis as dominant, with Calothrix pilosa and Nostoc muscorum also present. These species proved to be present on beach rock at other places on the lagoon shore. Newhouse (1954, p. 45) reports this association as the most ubiquitous on Raroia, from high tide line to below low tide on the lagoon shore. He also reports the dark coloration on the surface of the rocks due to discoloration of sheath material of Entophysalis by exposure to sunlight. This dark discoloration was also evident on Onotoa.

Shoreward from the ridge and sheltered by it, the lime-sand bottom had become hardened to the consistency of hard putty and had the same blue-green algae on the surface as listed above; however, at about one fourth inch depth was a second layer of blue-greens which consisted of Oscillatoria nigro-viridis, Lyngbya confervoides and Phormidium valderianum. It is proposed by Cloud (1954) and others that these blue-greens are binding the lime silt into beach rock. This same type of double-layered association was present at other places along the lagoon shore.

Frequently the beach rock had been eroded and shallow oval tide pools formed at different levels. These solution pools have been studied by Cloud (1954). They were filled with water by the high tide and the shallow bottoms were covered with algal growth. A solid mat of an alga tentatively identified as Enteromorpha compressa grew in these pools. Other collections from the pools are awaiting determinations.

### Lime-sand shoals.

The central lagoon along the shore of North Island had a fine lime sand bottom, populated by great numbers of sea cucumbers. Microdictyon and Bryopsis pennata were collected in the wash along the beach. Because of the shoal condition it is possible to wade and swim out into the lagoon about a 1000 feet. The algae were sparse on this shallow flat. Patches of a filamentous, gray colored species have been determined as Lyngbya confervoides. It grew on the sandy bottom, and as it proliferated it tended to accumulate mounds of the fine silt with only the ends of the filaments protruding. Farther out were small patches of Turbinaria ornata with Microdictyon growing with it. Caulerpa urvilliana was collected on rock fragments beyond the end of the jetty. The pebbles in this area were covered with pink coralline growth.

### Thalassia beds

North of the jetty on these sand flats there were large patches of Thalassia hemprichii that formed an almost solid stand. Attached to these plants and floating free among them was a species of Microdictyon.

Hydrocoleum floccosum was common along the shoreward edge of these beds. Caulerpa serrulata and Halimeda stuposa were present in the sandy areas between the Thalassia plants.

#### Northern lagoon.

Between the Thalassia beds and Aonteuma Island was a gravelly flat on which grew some living coral. At low tide these flats were covered by only about a foot of water, so the coral masses in many cases were truncated. The algae here were growing in sand pockets scattered between the masses of dead and living coral. Halimeda stuposa was the common alga here. Many of the specimens had developed thick heavy stipes that penetrated deeply into the sandy substrate. Lyngbya confervoides formed mounds of silt as described above. Dictyosphaeria intermedia, Boodleia van bossae and Caulerpa urvilliana were other common algae present. Laurencia grew on some of the coral knobs.

These same species were present on the shallow reef flat northeast of Aonteuma, but there was an increase in the number of Halimeda plants, including another species, Halimeda taenicola. Turbinaria ornata and Dictyurus purpurascens were also found here. Laurencia grew in the tide pools. A crustose coralline alga covered the surface of this reef in many places.

#### Western lagoon and reef.

The greatest concentration of algae species in the lagoon was on the western (leeward) reef and the coral knolls in the western part of the lagoon. Most of the Halimeda species found on the atoll were collected either on the reef or on the coral knolls. Many of these knolls were surrounded at their bases with a circle of Halimeda, but these did not form extensive meadows over the bottom as one sees in Florida. Caulerpa elongata, C. urvilliana, Dictyosphaeria cavernosa and Valonia aegagrophila were common in this area. Polysiphonia and Dasya were epiphytic on other algae. Coralline algae (Porolithon) formed huge spherical masses on the coral knolls, and crustose forms were covering the dead coral.

The deepest part of the lagoon was west of the village of Aiaki, South Island. Here on a bottom of dead and living coral at 48 feet grew Halimeda bikinensis and H. tridens forma tripartita.

#### Passage and Central lagoon reef.

Between North Island and Abenekenek Island was a passage covered with flowing water even at low tide. Most of the bottom was fine sand, but on the occasional dead and living coral grew Caulerpa urvilliana, Laurencia and many fine red algae. Frequently the rhizoidal process of the Caulerpa would grow off the coral and trail across the sandy bottom.



A shallow reef flat adjacent to the passage and extending into the lagoon at the southern tip of North Island was dry at low tide, except for the tide pools. Cladophoropsis, Dictyosphaeria, Valonia, Caulerpa urvilliana and Enteromorpha were growing on this reef. In the tide pools, Lyngbya confervoides grew and accumulated mounds of silt as observed before. Laurencia and Goniolithon also grew in the tide pools. The algal cover on this reef was sparse.

#### The seaward reef.

The seaward (windward) reef flat was covered by a fine algal turf. The distribution of the algae on this reef was studied by observations and collections made from time to time during July and August. After Dr. A. H. Banner had established a transect (A) to study the invertebrate fauna, one square foot of algal turf was scraped from the reef along this transect and preserved. These collections were made at 50 foot intervals, except where the flora showed no perceptible change. The accompanying table (1) shows the distribution of the principal species as determined at this time.

This reef can be divided roughly into five areas. Starting at the vegetation line on the beach rampart there is a sloping sandy beach or an outcropping of beach rock. On the sand at the high tide line there was usually a drift deposited after each high tide which included shells, seeds, plant fragments and algae of the reef.

The beach rock here had the same dark gray color on the surface as that present in the lagoon, the color being due to the presence of species of Entophysalis. The upper tide pools were 5 to 6 feet above the reef flat and were filled with water only from the splash of waves at high tide. They had a slimy black coating on the bottom formed by a species of Lyngbya. The slime coating was thin in these top pools and it was necessary to scrape vigorously to collect it. The middle pools were  $3\frac{1}{2}$  to 2 feet lower and contained a mat of twisted yellowish or brownish filaments. Entophysalis conferta, Lyngbya confervoides, L. semiplena (8064, 8067) and Enteromorpha (8066) were the principal species in these pools. Naviculoid diatoms were also present. Water entered these pools from the waves at high tide. Lyngbya meneghiniana (8350) was the alga of the bottom pools along with L. semiplena; this last was common on the reef at the beach line. Oxyrrhis marina, a pigmented dinoflagellate, and naviculoid diatoms were present among the filaments.

The inner zone of the reef flat itself looked barren and when dry was the color of the sand. Closer inspection showed a solid turf of a fine red alga almost completely covered with fine silt. Green algae grew around the edges of the pools shaded by the overhanging sides and on the underside of stones in the pools. The bottoms of many of these pools were usually scoured clean of algal growth. This type of reef extended to about the 250 foot quadrat.



The second zone of the reef had a predominantly green aspect from a distance and started roughly at the 300 foot quadrat. At low tide this part of the reef showed an almost continuous series of tide pools and standing water. Considerably more water was present here at low tide than on the reef at either side. Dictyosphaeria and Cladophoropsis were the common algae present, covering the flat itself and showing the darkest green around the edges of the pools and under the shaded overhang of projections. Jania capillacea made its appearance in this zone. Much fine silt was caught in the algal turf. The outer border of this reef zone merged with the next zone between 450 and 500 feet.

The third zone was red in color and extended to the coralline ridge at 600 feet. It was covered almost continuously with Jania decussatodichotoma. The Jania cover became heavier in the back-ridge trough which was filled with water continuously. Fleshy gelatinous red algae grew at the base of the Jania. Very few green algae were present, usually only Dictyosphaeria. A branched coralline alga, Goniolithon, occurred in the wider parts of this zone and sometimes formed solid stands. The outer edge of this zone was irregularly defined by the surge channels and mounds that extended back from the ridge itself.

The coralline ridge formed the outermost zone and was continually washed and battered by the heavy surf. This ridge was most spectacular in appearance, extending in each direction as far as the eye could see. Setchell (1924: Veg. of Rose Atoll, Car. Inst. Pub 341:243) quotes the Funafuti report in which this spectacular Onotoan reef was described. The same species that form the reef here at Onotoa, occur on Rose Atoll.

The ridge front was covered completely with a smooth pink crustose coralline alga, probably Porolithon onkodes. The ridge was broken by long, smooth-walled surge channels, 4 to 5 feet deep and gradually becoming shallower, ending in the back ridge trough. Each wave hitting the front of the ridge sent a rush of water up these surge channels into the back ridge trough. Alternating with the surge channels were dividing mounds 3 to 4 feet higher than the general elevation of the reef. These mounds were covered by upright pinnacles of Porolithon craspedium f. mayorii, pink in color, but fading to white on drying. Jania covered the base of the ridge as a short turf and also grew around the bases and between the blade-like projections of the Porolithon craspedium. Caulerpa urvilliana occasionally grew on the slope of these mounds. Very few of the cushiony greens occurred here. Dictyosphaeria setchellii grew along the surge channels. On the smooth shaded walls of the channels Rhipilia orientalis was inconspicuous, but common. Here is another example of the distribution mentioned by Doty (1954, p. 367) where the genus Rhipilia occurs on an atoll in the absence of the genus Sargassum.

#### Records for the square foot quadrats.

1. Beach line. (8123). Algal felt was scanty and short, giving barely any color to the reef surface. The bottoms of the pools at this level

were scoured clean. The dominant algal forms were small soft tufts with much sand intermingled, and these were identified as Schizothrix cresswellii and Lyngbya semiplena. A prolific branched species of Enteromorpha was fairly common.

2. Transect at 50 feet. (8124). A reddish color was observed on the reef flat here and the turf was more or less continuous. An alga tentatively identified as Pterocladia formed this reddish turf which was 8 to 10 mm. tall. Only the ends of the filaments protruded from the fine silt. Dictyosphaeria and Cladophoropsis, the green algae present, grew around the edges of tide pools. Small amounts of Jania capillacea grew in the cushions of the green algae. A Chroococcus-like blue-green alga formed dense mats around other algae.

3. Transect at 100 feet. (8125). The flora was much the same as described for the 50 foot transect. The growth of Pterocladia and the green algae bordering the tide pools was heavier. Porolithon onkodes encrusted pebbles in the tide pools.

4. Transect at 150 feet. (8126). Pterocladia was still present giving a reddish color to the reef flat. Cladophoropsis and Dictyosphaeria grew into huge cushions forming a solid ring around tide pools. Lyngbya sordida grew along the edges of these pools. Jania was growing mixed with Cladophoropsis.

5. Transect at 200 feet. (8136). Traces of Pterocladia were still present on the reef flat, but Cladophoropsis was dominant, extending out over the reef flat from the edges of the tide pools. Other species present as described in 150 foot transect.

6. No sample at 250 feet.

7. Transect at 300 feet. (8137). Species of green algae, Cladophoropsis, Boodlea and Dictyosphaeria completely encircled the pools and covered most of the reef flat. Red algae were very scarce at this station on the reef. Porolithon pebbles were present in the tide pools.

8. Transect at 350 feet. (8163). The turf covering the reef here was very short. Water covered most of this section of the reef at low tide. In addition to the species present at 300 feet, Jania capillacea was the dominant red alga present and grew over and mixed with Boodlea.

9. No sample at 400 feet.

10. Transect at 450 feet. (8164). The general aspect of the reef was still green at this station. The reef flat was dry here at low tide, but there were many tide pools filled with water. Green species were present as above. Laurencia, bleached yellow, was common in the tide pools. Crustose corallines were more common. Two species of Jania were abundant, with J. decussato-dichotoma the common species. An occasional specimen of Porolithon gardineri was found in this area.

11. Transect at 500 feet. (8168). The predominant color of the reef from this point to the surf line was red. Jania decussato-dichotoma was the dominant alga here on the reef flat. Laurencia was also common. Boodlea, Cladophoropsis and Dictyosphaeria grew around the edges and in the bottom of the tide pools.
12. Transect at 550 feet. (8169). Jania decussato-dichotoma had almost 100% cover at this station. A large species of Laurencia was present and a few small plants of Dictyosphaeria. Centroceras clavulatum was growing on the Laurencia. Goniolithon frutescens first appeared on the reef at this point.
13. Transect at 600 feet. (8170). The back ridge trough started at this quadrat. The reef flat was almost completely covered with an entangled growth of Jania and the branching coralline Goniolithon. The Laurencia growing here was frequently covered with epiphytic diatoms Licmophora and Cocconeis.
14. Transect at 650 feet. The coralline ridge constituted the outer zone of the reef and has been described above.

Table 1. Distribution of algae on the seaward (windward) reef.

Algae	Beach	50	100	150	200	300	350	450	500	550	600	650
		Distance from beach (feet)										
<i>Lyngbya semiplena</i>	D	t										
<i>Schizothrix creswellii</i>	D											
<i>Enteromorpha</i> sp.	D											
<i>Cladophoropsis</i> sp.		P	P	P	D	D	P	P	t	P	t	t
<i>Dictyosphaeria</i> spp.		P	P	t	t	D	P	P	P	t		
<i>Pterocladia</i> sp.		D	D	D								
<i>Jania capillacea</i>		t	t	P	P		D	P	P	P	P	P
<i>Porolithon onkodes</i>		t	P	P	P	P	P					
<i>Lyngbya sordida</i>				P								
<i>Laurencia</i> spp.				t		t			D	D	D	
<i>Boodlea</i> sp.						t	P	P	P	D	D	P
<i>Jania decussato-dichotoma</i>							P	D	D	D	D	
<i>Porolithon gardineri</i>								P		P	P	
<i>Goniolithon frutescens</i>												
<i>Porolithon craspedium</i>										P		D
<i>Caulerpa urvilliana</i>												P
<i>Rhipilia orientalis</i>												P
<i>Polysiphonia</i> sp.									t	t	t	t

Key: D-dominant species. P-present in fair quantity. t-traces only.

ALGAE

Tentative Species List

Myxophyta

Identification to species in this group were made by Dr. Francis Drouet, Chicago Museum of Natural History.

Anabaena sp.

North Island 8325.

A few filaments were found growing in a mat of Rhizoclonium hieroglyphicum on the sandy surface of a babai pit.

Anacystis dimidiata (Kütz.) Dr. & Daily

North Island 8166, 8345, 8346.

A member of the algal flora in the babai pits around the base of the Eleocharis plants. This species was also found in the thick mat on the surface of the brackish pools in the "caliche" soil area. This mat was orange in color on top, but olive-green below. It was also present in the granular bottom scum of these same pools. Other algae present in these mats were A. montana, Coccochloris stagnina, Lyngbya versicolor, L. aestuarii, L. guaymensis.

Anacystis montana (Lightf.) Dr. & Daily

North Island 8345, 8103; South Island 8216, 8217. Tabuarorae 8236.

This species was present as part of the flora in the mat on the surface of the brackish pools. It also occurred with Scytonema hofmannii on bare sandy areas between large coral fragments on the exposed northern tip of North Island. Blue green algae collected from coconut and Pandanus logs also contained this species associated with S. hofmannii.

Calothrix pilosa Harv.

Lagoon beach 8182, 8393.

A spongy mass on the beach and on beach rock at the high tide line; the collections were made at the north end of the lagoon near the village of Teneang. Growing here with other blue greens.

Coccochloris stagnina Spreng.

North Island 8324, 8345, 8346; Tabuarorae 8242.

One of the species common in the flora at the bottom of the babai pits, in one case associated with Plectonema nostocorum. This species was also found as a member of the floating mat described under Anacystis dimidiata.



Entophysalis conferta (Kütz.) Dr. & Daily

North Island 8064

Growing in the middle tide pools of the beach rock outcrop on the seaward side of the North Island at the camp site. These are the tide pools studied in respect to their pH and temperature, as reported by Cloud (Atoll Res. Bull. #12, 1952). This species also covered the beach rock and gave it a bluish color, (see Newhouse, 1954. Atoll Research Bull. #33: 53). Other species present in the tide pool were Lyngbya confervoides and L. semiplena.

Entophysalis crustacea (J. Ag.) Dr. & Daily

North Island 8182.

Found covering the beach rock at high tide level in the lagoon near the village of Teneang. Associated with Calothrix pilosa and other blue greens.

Entophysalis deusta (Menegh.) Dr. & Daily

North Island 8183.

Growing on beach rock at high tide level, 100 feet from shore. Same area as E. crustacea.

Fischerella ambigua (Nag.) Gom.

North Island 8144.

Found on the soil at the top edge of a babai pit. Associated with Scytonema hofmannii.

Hydrocoleum floccosum (Hauck.) Gom.

Lagoon 8190.

Growing on the bottom of the lagoon and covered at low tide. Common at the shore end of the Thalassia beds (turtle grass).

Lyngbya aestuarii Gom.

North Island 8119.

A member of the community of algae in the scum on the brackish pools. See Anacystis.

Lyngbya confervoides Ag.

Lagoon 8026, 8028, 8182; North Island 8064.

Growing on the lagoon reef flat at the south tip of North Island, at low tide level about 100 feet from shore. The fur of filaments had become filled with fine lime silt, so that only the tips showed above the loose mass. This condition was noticed at other places over the lagoon bottom. This species was also a member of the flora in the middle tide pools of the beach rock on the seaward side of North Island. It was found associated with Entophysalis crustacea on beach rock in the lagoon. At one site this species formed a dark blue green stratum about  $\frac{1}{4}$  of an inch below the surface of the soft beach rock.

Lyngbya guaymensis Dr.

North Island 8119, 8345.

A member of the floating mat community in the brackish pools. See description under Anacystis dimidiata.

Lyngbya meneghiniana (Kütz.) Gom.

North Island 8350.

A member of the flora growing in the lowest tide pools in the beach rock on the seaward side of North Island.

Lyngbya semiplena Gom.

North Island 8064, 8067; seaward reef 8123.

A member of the algal community from the middle tide pools of the beach rock on the seaward side of North Island. With Entophysalis conferta and Lyngbya confervoides. In the first of a series of transects scraped from the seaward reef, this species with Schizothrix cresswellii were members of the algal felt covering the reef at beach level.

Lyngbya sordida (Zanard.) Gom.

Seaward reef 8390C, 8482C.

This plant was present in the tide pools of the green algal zone of the seaward reef, associated with Dictyosphaeria.

Lyngbya versicolor Gom.

North Island 8119, 8345, 8346.

This species was growing in the floating mat community and in the granular bottom deposits in the brackish pools of the "caliche" area. See under Anacystis dimidiata.

Merismopedia sp.

North Island 8166.

In the material collected from the babai pits a few specimens of this genus were found.

Microcoleus chthonoplastes (Fl. Dan.) Thur.

North Island 8134, 8473; lagoon 8180.

One of the algae present in the soil community of the old dune sands of the rampart on the seaward side of North Island. Growing with Scytonema hofmannii. It was also found on the lagoon beach.

Nostoc muscorum Ag.

Lagoon 8179.

Occurring on exposed, incipient beach rock of the lagoon at low tide level, with Scytonema hofmannii.

Nostoc sp.

North Island 8320, 8322.

Young material was growing on the soil of a path in the center of North Island in a community including Schizothrix heufleri and Scytonema hofmannii. Drouet reports that the material in 8322, which was associated with a moss, was parasitized.

Oscillatoria nigro-viridis (Thur.) Gom.

Lagoon 8182B.

This species formed a light green stratum in beach rock at high tide level in the lagoon at the profile studied at the village of Taneang, North Island. Here it was associated with Lyngbya, Calothrix and Phormidium valderiarnum.

Phormidium crosbyanum Tild.

Bikati Island, Big Makin Atoll, Gilbert Islands 8009.

This species covered the coral rocks and lined the depressions on the reef at high tide level.

Phormidium valderiarnum Gom.

Lagoon 8182B.

Associated with Oscillatoria nigro-viridis which see.

Plectonema nostocorum Gom.

Tabuarorae 8242.

This alga was present in the mat in the bottom of an abandoned babai pit, growing with Coccochloris stagnina around the stems of Eleocharis.

Schizothrix cresswellii Haw.

Seaward reef 8123.

With Lyngbya semiplena, growing in the first transect of algae scraped from the seaward reef at beach level.

Schizothrix friesii (Ag.) Gom.

North Island 8111, 8285, 8321; Tabuarorae 8240.

Covering the soil (silty loam) on paths, in the sun as well as in the shade. It was also collected on the beach rampart. Most frequently it was associated with Scytonema hofmannii.

Schizothrix heufleri Grun.

North Island 8320.

The skin-like coating on the soil surface of a path in the center of North Island was formed by this alga and two associates, Scytonema hofmannii and young Nostoc.

Scytonema guyanense (Mont.) Born. & Flah.

North Island 8118.

This species was growing on the roots of a fallen coconut tree.

Scytonema hofmannii Ag.

North Island 8103, 8134, 8144, 8160, 8285, 8321, 8322, 8473; lagoon 8179; South Island 8215, 8217; Tabuarorae 8236.

The common blue green alga of the soil community, it was found growing on the paths, roads, seaward rampart and logs. It also occurred in the babai pits. Only one collection was found on the beach rocks in the lagoon, where it was associated with Nostoc muscorum. In the soil collection it grew with a wide variety of blue-greens including the following genera: Anacystis, Fischerella, Microcoleus, Nostoc and Schizothrix.

Scytonema ocellatum Lyngby

North Island 8096; Tabuarorae 8241B.

The black tufts of this alga resembled the moss plants with which it grew. It was found on lime sand soil along the lagoon road, usually in deep shade.

Chlorophyta

Avrainvillea sp.

Western Reef 8443.

This is probably A. nigricans Dec. but final determination has not been made. Growing in 5 feet of water attached to coral rocks. The plant was  $4\frac{1}{2}$  cm tall.

Boodlea sp.

Seaward reef 8137, 8163.

Scattered plants of this unidentified Boodlea grew on the seaward reef. This area was dry at low tide except for the tide pools which were usually clear of algae. In the preliminary survey of the algal belt scraped from the seaward reef this species was found sparingly in the 300-foot transect along with other green algae, but in the 350-foot transect it formed a turf overgrown with Jania capillacea.

Boodlea vanbosseae Reinbold.

Lagoon 8421.

This species grew on the flats at the northwest corner of the atoll and was exposed at low tide. It was growing with Ceramium and Polysiphonia.

Bryopsis pennata Lam.

Lagoon 8354.

The only specimen of this plant that has been found in the collections so far was a thick mat washed up on the lagoon beach.

Caulerpa elongata Weber Van Bosse.

Lagoon 8260, 8261, 8263, 8401, 8452.

This species of Caulerpa was confined to the western side of the lagoon. All but one specimen were attached tightly to coral rocks. The exception was found growing on Valonia aegagrophila, which was attached to coral rock. Both f. typica and f. disticha were recorded. Because of its



small size this species may have been overlooked frequently.

Caulerpa serrulata (Forssk.) J. Ag.

Lagoon 8052, 8425; Betio, Tarawa Atoll 8624.

The specimens assigned to this species were confined to shallow water in the central part of the Onotoa lagoon on lime sand bottom. It also grew in the Thalassia patches of the north central lagoon. The Tarawa specimen was collected on the western seaward reef of Betio.

Caulerpa urvilliana Mont.

Lagoon 8029, 8052, 8249, 8235A, 8317, 8408, 8409, 8425, 8433.

West reef at Aonteuma 8100; flat, east of Aonteuma 8423.

Water-way between islands 8143, 8445; seaward reef 8174, 8188.

The commonest species of Caulerpa on the atoll. It grew in shallow waters, uncovered at low tide, down to a depth of 14 feet. It was present in the patches of Thalassia in the lagoon. The isolated patches of coral in the flowing water between the islands had growths of this Caulerpa on them. It was attached by the root-like structures of the horizontal rhizoid to coral rock, lime sand, living blue coral and the coralline algae crust of the seaward ridge. Wherever it grew the habit of the plant tended to cause the deposition of silt. Microdictyon and many small red algae grew upon it as epiphytes.

Chaetomorpha sp.

Lagoon 8475.

A species assigned tentatively to this genus was found growing on the bottom of one of the boats we used for survey work in the lagoon. The boat had been in the lagoon water continuously from June 30th to August 28th. Enteromorpha was also present.

Cladophoropsis sp.

Seaward reef 8136, 8137.

A member of the green algal community on the seaward reef. It was the dominant species at 200 feet from shore, but codominant with Dictyosphaeria at 300 feet.

Dictyosphaeria sp.

Seaward reef 8164; lagoon 8026, 8263.

The specimens have not been determined to species at the time of this writing. The specimen from the seaward reef was growing at 450 feet from shore and was not abundant. The other specimens were found on a reef

flat, 100 feet from shore just at low tide level. Also growing with Valonia on coral rocks on the lagoon side of the western reef.

Dictyosphaeria cavernosa (Forssk.) Borg.

Seaward reef 8137, 8390, 8482B; lagoon 8278, 8309, 8456, 8479, 8421; Betio, Tarawa Atoll 8632.

The common species of Onotoa Atoll. An abundant plant on the seaward reef, codominant with Cladophoropsis at 300 feet from the shore. It was common in the lagoon on coral knolls and rocks to a depth of 10 feet. Many of the hollow globular plants had split open into irregular flat masses. Collected also on the seaward reef of Betio Island, Tarawa Atoll.

Dictyosphaeria intermedia Weber Van Bosse

Seaward reef 8163, 8390B; reef flat northwest corner of Atoll 8421.

This species grew on the seaward reef at 350 feet from shore. It occurred also on the vast flat at the northwest end of the atoll where it was exposed at low tide. There are many collections of this genus remaining to be determined so other examples of this species will no doubt be found.

Dictyosphaeria setchellii Borg.

Seaward reef 8045.

This species has been found only once in the collections examined to date. It was collected on the ridges between the surge channels on the seaward reef. Here the surf washes over it even at low tide and it is never completely dry. Trabeculae inside the cells were many and measured 100 to 118 microns in length. Some of them were forked.

Enteromorpha sp.

Lagoon 8475.

An undetermined species was collected on the bottom of one of the boats used in the lagoon. See under Chaetomorpha. This species of Enteromorpha is only slightly branched.

Enteromorpha compressa (L.) Grev.

Lagoon 8181.

This Enteromorpha was growing at the base of the beach rock at high tide level in the lagoon, at the village of Taneang. A detailed paper analyzing the Halimeda is in manuscript and will be published separately soon.

Halimeda opuntia (L.) Lam.

Western Reef 8115B, 8249, 8249B, 8256A, 8256B, 8257, 8258, 8272A; lagoon 8318, 8398A, 8441, 8471; seaward reef 8478.

The most common and widely distributed species on the atoll. Most of the collections were from the western reef or coral knolls along the western side of the lagoon. Only one specimen was collected on the windward or seaward reef and it had been washed into a tide pool. Never abundant but generally growing in small patches or in a circle, turf-like, around the bases of the coral knolls, from just below the surface to a depth of 6 meters.

Halimeda bikinensis W. R. Taylor

Lagoon 8467.

This species described by Taylor (Plants of Bikini, University of Michigan Press, 1950) from Bikini was collected at only one location, in the deepest part of the lagoon, opposite the village of Aiaki, South Island. The bottom here was lime mud and sand. The depth of water was 48 feet.

Halimeda fragilis W. R. Taylor

Lagoon 8246, 8265, 8438; western reef 8272B.

This species was also first described by Taylor from Bikini. Specimens were collected from the western reef on both the lagoon and seaward side, and on coral knolls. It was found growing in water 3 to 12 feet deep, on lime sand and coral rock bottom.

Halimeda orientalis Gilbert

Lagoon 8409.

Apparently rare since only one collection was made. This was found in the western side of the lagoon between the reef Rakai Taka and Rakai Ati in 3 feet of water.

Halimeda stuposa W. R. Taylor

Western reef 8115; sand flats of Aonteuma 8113, 8481; lagoon 8221, 8277, 8359A, 8426.

This species was very abundant in the shallow sandy north portion of the lagoon and on the shallow sandy windward reef flats extending north east from Aonteuma. Fairly common in the shallow area covered with Thalassia. In many of these habitats the plants were partly or entirely exposed at low tide. One collection was made on the leeward reef west of Aonteuma Island, in a surge channel.

Halimeda taenicola W. R. Taylor

Western reef 8116, 8270; reef flat northeast of Aonteuma 8434.

This large and heavily calcified species was found growing on the leeward reef in surge channels and holes in the reef. Most of the specimens collected were in 6 to 11 feet of water. Found growing with H. opuntia.

Halimeda tridens (Ellis & Solander) Lamouroux f. tripartita (Barton) Collins.

Western reef 8271; lagoon 8468.

Not a common species. Found in the deepest part of the lagoon at 48 feet with H. bikinensis, and on the seaward edge of the leeward reef in 6 to 11 feet of water.

Microdictyon sp.

Lagoon 8263; tide pool, seaward reef 8478.

Much of the Microdictyon collected remain to be determined. These algae were very common along the shore of the lagoon and in the Thalassia beds. Specimen 8263 was growing on coral rocks with Valonia in the western area of the lagoon. Number 8478 was collected from a tide pool on the seaward reef with blue green algae.

Microdictyon umbilicatum Vellay.

Lagoon 8409.

Growing with Halimeda in the western area of the lagoon.

Rhipilia orientalis A. and E. S. Gepp

Seaward reef 8370, 8380.

Fairly common as a fungus-like growth on the smooth walls of the surge channels on the seaward reef in shaded situations. Exposed at low tide only between waves. Polysiphonia was epiphytic on these plants.

Rhizoclonium hieroglyphicum (Ag.) Kütz.

North Island 8046, 8135, 8166, 8325.

A common member of the freshwater algal community in the babai pits, sometimes forming huge mats covering the entire surface. At other times mixed with the blue greens present. Also found growing in one of the freshwater wells where the water level was 15 feet below the soil surface.

Valonia aegagrophila C. Ag.

Lagoon 8263; seaward reef 8287.

One collection was on coral rocks on the lagoon side of the western reef. The other was growing nearly 300 feet from shore on the seaward reef, mixed with other algae in the turf covering the reef.

#### Pyrrophyta

##### Exuviella sp.

Present in masses of Cladophoropsis and blue greens examined under the microscope at the time of collection.

#### Chrysophyta

(Diatoms)

Cocconeis sp. Present as an epiphyte on other algae growing at 600 feet from beach on seaward Transect A.

##### Licmophora sp.

A very common epiphyte, especially on material collected in August. Found growing on Laurencia, Ceramium and other algae on the seaward reef and in the back-ridge trough of this reef. Also common on algae collected from the lagoon.

##### Podocystis sp.

An occasional epiphyte on other algae.

##### Striatella unipunctata (Lyngbye) Agardh

Noticed as an occasional epiphyte on Jania and other red algae.

##### Unidentified diatom

An unidentified epiphyte covered plants of Dasya (8264) and Polysiphonia collected on the lagoon side of the western reef.

#### Euglenophyta

##### Euglena spp.

North Island 8138, 8166.

An uncommon member of the algal community in the bottom of the babai pits. With Anacystis and Phacus.

##### Phacus pleuronectes (O.F.Mull.) Duj.

North Island 8138.



The dominant organism present in water collected from the bottom of one of the babai pits. Euglena and a few ciliates the only other organisms present.

#### Phaeophyta

##### Turbinaria ornata J. Ag.

Seaward reef 8017, 8032, 8122, 8482A; lagoon 8075, 8221, 8276; reef flat northwest corner of atoll 8421; Rongerik Island, Majuro Atoll, Marshall Islands 8004.

The specimens from the seaward reef were picked up in the wash on the beach and probably came from beyond the coralline ridge, since this species did not occur on the reef flat itself. The only fertile specimen came from the seaward reef. The lagoon specimens were growing in irregular patches on coral fragments in  $4\frac{1}{2}$  feet of water, 200 feet from shore. The specimens from the reef flat at the northwest end of the atoll were growing exposed at low tide.

##### Padina sp.

Collected from the seaward reef (western reef) of the Island of Betio, Tarawa Atoll in September on the return trip. This alga was noticed as very common at the landing on Majuro, Marshall Islands, but not collected. Missing from the flora of Onotoa.

#### Rhodophyta

##### Ceramium sp.

Noticed as one of the fine epiphytic algae growing on many of the larger algae on the seaward reef and in the lagoon.

##### Centrocerus clavatum (C. Agardh) Montagne

Seaward reef 8289.

Growing epiphytically over Laurencia and Jania on the outer end of the seaward reef. This species, occurring very commonly as a fine fuzzy epiphytic growth tightly attached and intertwined, was found in examining many other algae.

##### Dasya sp.

Lagoon 8261, 8264.

The two specimens above after preliminary examination seem to belong to this genus. Both grew on coral rock in the western side of the lagoon and were associated with Caulerpa and Polysiphonia.

Dictyurus purpurascens Bory

Reef northeast of Aonteuma 8358; reef shoals outside coralline ridge 8458.

One specimen was growing in water 8 feet deep at low tide and was growing in a hole in a coral head. The other on coral rock outside the coralline ridge on the seaward side of North Island.

Jania sp.

Lagoon 8026; seaward reef 8164, 8289.

These specimens have not been satisfactorily determined at the present writing. The one from the lagoon grew on a reef flat at the south end of North Island and was exposed at low tide. The other two were collected with Laurencia and Centrocerus on the outer end of the seaward reef in the red algal zone.

Jania capillacea Harvey

Seaward reef 8136, 8163, 8164, 8287.

A very common member of the algal turf community on the seaward reef. It first appeared in collections at 200 feet from shore, attached to Cladophoropsis. It became dominant at 350 feet. It was less common at 450 feet where it was growing on Laurencia. The following species of Jania replaced it here in abundance.

Jania decussato-dichotoma (Yendo) Yendo

Seaward reef 8163, 8164.

This species first appeared on the seaward reef at 350 feet from shore and became the dominant form of Jania on the outer end of the reef from 450 feet to 600 feet. At 450 feet it shared dominance with Laurencia, while from 500 to 600 feet it grew on and over the crustose Porolithon onkodes.

Laurencia sp.

None of the members of this genus have been determined to species at this writing.

Lagoon reef flat 8026; seaward reef 8164, 8287, 8289, 8367.

In the lagoon this alga was growing on the reef flat at the south end of North Island in pools and in some cases partly exposed at low tide. It grew on the seaward reef from 450 feet to 600 feet from shore associated with Jania, Valonia, Centrocerus. In August it was covered with epiphytic diatoms of the genus Licmophora. It was a dominant member of the reef flora at 450 feet. Several species are represented by the collections.

Polysiphonia sp.

Lagoon 8026.

The species of Polysiphonia examined to date are sterile and have not been determined to species. The genus grows as part of the filamentous fuzz on larger algae such as Laurencia, Caulerpa, Jania, and Dasya.

Porolithon gardineri (Foslie) Foslie

Seaward reef 8164.

The determination of the coralline red algae remains to be done. The two specimens identified tentatively as this species were collected in the one square foot transect on the seaward reef at 450 feet.

Porolithon onkodes (Heydrich) Foslie

Seaward reef 8136, 8137, 8163.

Only a tentative identification of this crustose alga. Found growing on pebbles in the tide pools of the seaward reef at 200, 300, and 350 feet from shore. Presumed to be the pavement crust at 550 feet and out over the coralline ridge.

Porolithon craspedium (Foslie) Foslie

Coralline ridge 8371, 8372.

The dominant coralline on top of the ridges separating the surge channels. Blue green algae, possibly an Oscillatoria, and Jania growing down in the creases between the blade-like structures.

Pterocladia sp.

The shoreward edge of the seaward reef is covered by a short red alga with only the bleached tips showing above the silt. After preliminary examination of this plant I have tentatively placed it in this genus. It is the dominant member of the algal community on the reef from 50 feet to 100 feet and is associated here with a few plants of Cladophoropsis.